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The People's Republic of China's Import Competition and Skill Demand in Japanese Manufacturing

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Abstract

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Keywords

Japan, manufacturing, import competition, China, skilled workers, labor demand

Comments

Suggested Citation

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ADB Working Paper Series

**THE PEOPLE'S REPUBLIC OF
CHINA'S IMPORT COMPETITION
AND SKILL DEMAND IN
JAPANESE MANUFACTURING**

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No. 644
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Asian Development Bank Institute

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This paper examines the hypothesis that manufacturing industries in Japan that have been exposed to import competition from the People's Republic of China (PRC) experience greater skill upgrading (increased demand for skilled workers). Using an industry panel dataset over the period 1980–2010, we exploit variations of worker skill categories by occupation, paired with detailed information and communication technology investment data in the employment share regression. We find that while the PRC's comparative advantages in exports have shifted from labor-intensive to more capital-intensive products, this has not resulted in substituting skilled workers in Japanese manufacturing. Rather, it has had the profound positive effect of raising overall demand for skilled workers. Most of the competition effects were felt among production workers, leaving middle-skilled workers largely unaffected.

JEL Classification: D24, F17, O47, O57, R15

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1. INTRODUCTION

The well-documented historic rise of the People's Republic of China (PRC) as a trading powerhouse has exerted competitive shocks on the world economy and raised serious concerns among policy circles in industrial economies. These concerns have been directed toward the PRC's import competition as it pertains to the labor market, especially since it joined the WTO in 2001. The literature on this issue has grown to examine the various margins of labor market adjustments at the level of industries, firms, individual workers, and regional economies (Autor, Dorn and Hanson 2013; Autor, et. al. 2015; Ashournia, Munch and Nguyen 2014; Hummels, Munch and Xiang 2014).¹ The overall finding in the literature regards significant wage depression and labor relocation effects on lower-skilled workers whose tasks can easily be off-shored and substituted by the PRC's imports. As a result, demand for skilled workers in importing countries has increased.

In this context, this paper examines the relative contributions of PRC import competition on the observed skill demand shift based on a panel dataset of 52 Japanese manufacturing industries for the period 1980–2009. Using rich information extracted from the Japan Industrial Productivity (JIP) database, we examine the PRC import competition industry variation and its effects on skill demand, while controlling for a proxy for skilled-biased technological changes (SBTC) and other confounding factors. The data coverage is long enough to track a shift in the PRC's comparative advantages from more labor-intensive products toward more capital- and technology-intensive products (to be discussed fully in the next section). This has different implications for the labor market as the intensity of the competition effects is expected to shift from lower-skilled to higher-skilled workers in Japanese manufacturing.

We use the occupation groups as an imperfect proxy for skill intensity. In this framework, we look at the two intertwining forces at play in skill demand: PRC import competition may exert stronger pressures on lower-skilled jobs via depressed wages that hurt employment prospects. At the same time, information communication technology (ICT) increasingly requires correspondingly skilled workers. Both factors increase demand for higher-skilled workers, but depress demand for lower-skilled workers, while leaving an ambiguous effect on middle-skilled workers. This is our working hypothesis which we will use for data in a regression analysis.

The organization of this paper is as follows: The next section briefly describes PRC export performance with Japan's changing labor market. Section 3 discusses the dataset, followed by the interpretation of the results in Section 4. The final section summarizes the key findings and derives the policy implications for a possible PRC economic growth slowdown.

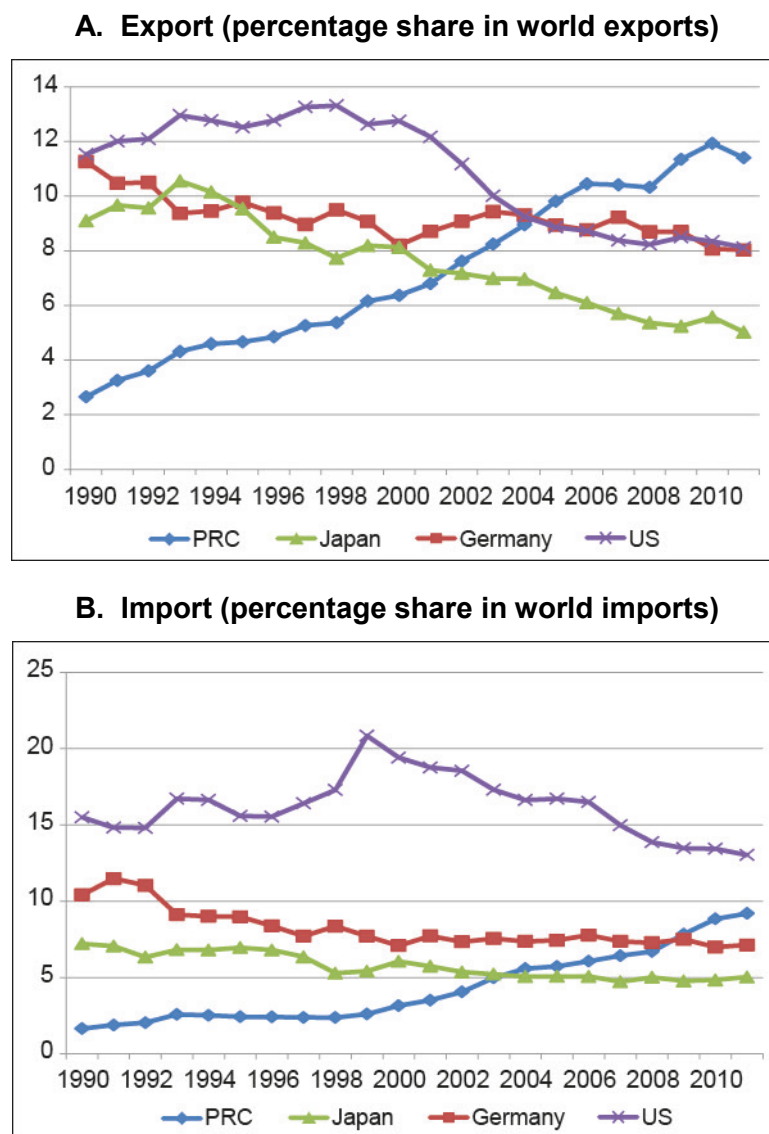
2. THE RISE OF THE PRC IN WORLD TRADE

Figure 1-A depicts the rise of the PRC in world exports for the period 1990–2011. In 1990, the PRC's exports accounted for a tiny share (around 3%) of world exports. Since then, the PRC's share has gradually increased. In particular, PRC exports grew rapidly starting around the early 2000s. In the second half of the 2000s, the PRC

¹ The shift in focus from the aggregate industry level has gone through the firm-level stage since the work of Bernard et al. (2006), followed by Mion and Zhu (2013), and Bloom et al. (2011). For a comprehensive review of the literature with this transition, see Hummels et al. (2014).

achieved a formidable export expansion, overtaking Germany as the world's largest exporter and accounting for 10% of world exports. The PRC's export share has grown without any disruptions, while those of Japan, the US, and Germany have not grown during the same period. At the same time, the PRC has become an important economy in the world import market (Figure 1-B). While the US still accounts for the bulk of world imports (around 15%–20%), its share has gradually declined since 2000. By contrast, the PRC's share has been steadily increasing from the lower base accounting to close to 10% in 2011.

Figure 1: The Rise of the PRC in World Trade, 1990–2011
(%)



Note: PRC = People's Republic of China.

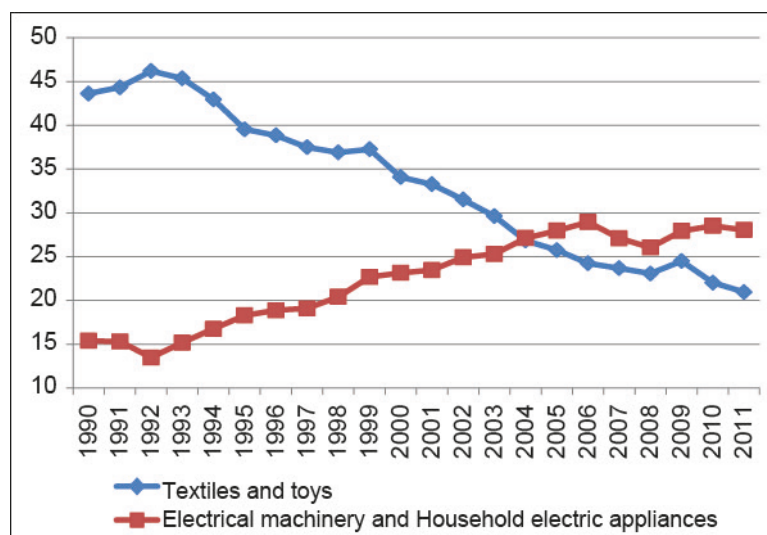
Source: UN Comtrade (<https://comtrade.un.org/>)

The rise of the PRC in world trade has dramatically changed its specialization. Figure 2 depicts the share of more capital- and technology-intensive electrical machinery and household appliances as compared to the more labor-intensive textiles and toys, showing a shift of comparative advantages from the latter to the former. In 1992,

textiles and toys accounted for around 45% of the PRC's total exports. However, its share subsequently dropped to close to 20% in 2011. On the other hand, the export share of electrical machinery and household appliances doubled from less than 15% in 1992 to 30% in 2011. This shift was largely driven by ICT.

This finding has led others to argue that the PRC has been quickly climbing up the technological ladder. For example, based on the income-weighted export bundle of PRC goods, Rodrik (2006) contended that PRC capabilities are rapidly converging to lead the world technological frontier. However, total value trade statistics might be misleading; indeed, allowing for the role played by processing exports in the PRC trade structure undermines this conclusion. That is, it is well known that the PRC's export specialization still largely rests on the labor-intensive assembly stage rather than specialization in technological content (Athukorala and Yamashita 2009). In essence, the PRC has grown to be an exporter of labor-intensive assembly goods, but still the bulk of technologically advanced parts and components embedded in export goods come from other high-wage countries (such as Taipei, China; Japan; the US; and Europe). In other words, the PRC's comparative advantages still rest on the labor-intensive segment in high-tech products, even though these products are exported. These products tend to be mass-market commodities with relatively low unit costs (notebook computers, mobile phones), and possibly shorter product life cycles to avoid the risk of imitation. This explains why Schott (2008) observed that, while the unit price of PRC export bundles are relatively low as compared to those of Organisation for Economic Co-operation and Development (OECD) economies, they have, over time, started to resemble those of OECD economies.

Figure 2: Structural Changes in PRC Export Product Compositions, 1990–2011
(% in total exports)



Source: UN Comtrade (<https://comtrade.un.org/>)

PRC Import Competition in Japan

Table 1 sorts the top and bottom 10 industries by degree of PRC import competition in 1980. In the textile industry, where PRC firms were considered to have comparative advantages, import competition was keenly felt: though less than 20% of Japanese textile imports came from the PRC in 1980, by 2009, the share had jumped to 80%. More strikingly, the competitive shift can be observed for the bottom 10 industries (mostly high-tech) that experienced an influx of PRC imports between 1980 and 2009.

Apart from motor vehicles, industries with negligible PRC import presence in 1980 were, by 2009, subject to intensified competition.

Table 1: Change in Import Competition by Source Countries/Groups in Japanese Manufacturing, 1980–2009

JIP Industry	The PRC		Asian NIEs		SE Asia		US	
	1980	2009	1980	2009	1980	2009	1980	2009
The Top 10 Sectors in 1980								
28 Miscellaneous chemical products	3.85	13.24	2.56	9.04	1.63	12.39	55.18	26.60
59 Miscellaneous manufacturing industries	3.89	56.19	20.00	5.63	2.56	10.07	21.97	9.61
33 Cement and its products	4.16	44.10	20.58	27.91	0.03	14.22	15.40	2.95
24 Basic inorganic chemicals	5.74	30.94	5.43	8.06	1.43	5.11	22.50	18.35
17 Furniture and fixtures	6.85	52.44	55.74	5.77	10.64	27.08	5.16	1.58
34 Pottery	7.43	48.38	5.27	6.03	0.42	17.19	17.88	5.24
25 Basic organic chemicals	7.94	2.40	15.73	92.28	0.00	0.00	46.67	0.04
15 Textile products	17.65	80.09	39.01	2.31	2.49	7.43	5.44	1.24
12 Prepared animal foods and organic fertilizers	34.33	10.72	5.01	1.95	10.52	20.27	30.51	25.71
31 Coal products	36.19	64.28	28.38	4.10	0.00	0.18	23.51	4.20
The Bottom 10 Sectors in 1980								
27 Chemical fibers	0.00	16.07	45.60	35.18	1.82	14.11	32.05	12.06
48 Electronic data processing machines,	0.00	63.26	1.70	13.08	0.01	10.61	71.59	5.82
51 Semiconductor devices and integrated circuits	0.00	10.85	20.00	50.61	12.26	11.48	55.34	19.19
52 Electronic parts	0.00	42.39	53.71	26.55	0.05	16.60	32.56	8.60
56 Other transportation equipment	0.00	8.86	1.40	2.46	0.57	0.52	60.58	72.40
45 Office and service industry machines	0.00	81.59	9.08	6.91	0.33	5.79	40.77	2.36
50 Electronic equipment and electric instruments	0.00	24.92	1.28	5.72	0.00	3.73	77.14	29.84
42 General industry machinery	0.01	31.10	1.28	14.84	0.07	10.29	57.06	16.74
55 Motor vehicle parts and accessories	0.02	29.68	3.82	9.30	3.32	18.18	39.99	8.90
44 Miscellaneous machinery	0.02	30.57	9.05	18.83	1.14	14.15	47.90	16.33
54 Motor vehicles	0.02	2.72	0.02	3.96	0.01	2.84	23.82	8.40

Source: JIP 2013 database.

3. EMPIRICAL METHOD, DATA, AND VARIABLE CONSTRUCTION

Empirical Method

We follow the conventional estimation specification used in the SBTC literature (Berman, Bound, and Griliches 1994; Machin and Van Reenen 1998; Feestra and Hanson 1999).² The baseline specification can be written as follows:

² See Technical Appendix for the derivation of the cost-share equation, as commonly used in this literature.

$$Sh_{it} = \alpha_i + \alpha_t + \beta_1 CHM_{it} + \gamma Z_i + \varepsilon_{it} \quad (1)$$

where subscripts i and t denote industry and time, respectively. The dependent variable (Sh) is the employment share of workers according to occupation. In the literature, the dependent variables usually adopt the cost share for a relevant skill category (e.g., skilled worker wage bills divided by the total in a given industry). However, in the case of Japan, the employment indicator seems to be a more appropriate variable for analyzing skill upgrading.³

We consider the following occupations: technical and professional managers (denoted as Tech) as skilled workers; office, sales and services workers as middle skilled; and assembly and manual labor workers (Production) as lower skilled. A vector of other variables, \mathbf{Z} , includes value added (a proxy for the scale economies), ICT capital stock to value added, non-ICT capital stock to value added, R&D intensity, and import penetration from other economies (other than the PRC). Technically speaking, the inclusion of these additional controls may actually induce the “bad controls” problem as described in Angrist and Pischke (2009)—they themselves may be outcomes of the key explanatory variable and therefore bias its estimate. For this consideration, we use the two-year lags of these additional controls.

The adoption of ICT in workplaces has facilitated a shift of production technologies in favor of skilled workers. Autor et al. (2013) emphasized that ICT substitutes for routine tasks, but complements non-routine cognitive tasks. Furthermore, many routine tasks requiring medium skill sets (or middle-level education), such as bank clerks and telephone operators, have found the demand for their services falling as a result of ICT investment in OECD economies (Michaels et al. 2014). At the other end of the occupational spectrum, jobs requiring non-routine manual tasks (janitors, taxi drivers, and aged care workers) might not be affected much by ICT because of the difficulty of automation in these tasks. In short, this strand of literature revealed that trade (especially imports from low-wage economies) and ICT investment together have contributed to the polarization of US and Europe labor market skill demand.

The sign of value added, *ceteris paribus*, depends on whether the expansion of the industry output scale would require more skilled workers. If the estimate coefficients are zero, the hypothesis that the underlying production function is homothetic cannot be rejected. Otherwise, it implies that it is non-homothetic, suggesting the ratio of the optimal inputs demands depend on the level of outputs.

Both the time-specific and industry-fixed effect are also incorporated in order to guard against omitted variables for explaining the employment share of skilled workers in the respective dimensions: the former is needed to control for any unmeasurable (or unobserved) time-invariant heterogeneity, such as industry-specific persistent technological differences or difference in the average management quality. Time-specific effects are also introduced to control for a homogenous form of technological

³ An alternative measure is the share of skilled workers in the total wage bills of all workers. However, this cannot be computed for the time period covered in this paper because of the unavailability of disaggregated industry-level wage data for nonproduction workers. Two data sources are generally available for compiling the wage bills of Japanese manufacturing nonproduction/production workers: the *Census of Manufactures* (CM) from the Japan Ministry of Economy, Trade and Investment, and the *Basic Survey on Wage Structure* (BSWS) from the Ministry of Health, Labour, and Welfare. The CM includes cash earnings of production and nonproduction workers at the detailed 4-digit level of Japan Statistical Industry Classification. However, since 1990, this information has become unavailable in the CM published data. The BSWS provides wage earnings data for nonproduction and production workers, but they are available only for the total manufacturing industry from 1985 onward.

change across industries, but varying across time as well as capturing other macroeconomics shocks.

3.1 Data

Variables used in the regression analysis are mainly sourced from the Research Institute of Economy, Trade and Industry's (RIETI) Japan Industrial Productivity (JIP 2013) online database.⁴ We use the annual data for the period 1980–2009.⁵ The time coverage is ideal since PRC import competition has accelerated in 2000s after its WTO admission in 2001 and the ICT revolution generally started to accelerate in the mid-1990s. The JIP dataset is organized in 3-digit industry levels (52 manufacturing industries) with several useful variables for our purpose, which we describe below.

PRC Import Penetration

We use the value of imports originating from the PRC (IM^{China}) as a share of total world imports (IM^{World}) to measure the exposure to PRC import competition in a given JIP industry.

$$CHN_i = \frac{\text{Chinese imports}_i}{\text{Imports}_i} \quad (2)$$

We also employ the conventional method of constructing PRC import penetration by normalizing PRC imports on domestic absorption (i.e., domestic absorption = value added + imports – exports).⁶

$$CHN_i = \frac{\text{Chinese imports}_i}{(\text{Value Added}_i + \text{Imports}_i - \text{Exports}_i)} \quad (3)$$

An Indirect Measure of Skills

Proper skill intensity measurement must account for educational attainment, on-the-job training, and work experience (Hamermesh 1993). However, there is no single measure to capture these with available datasets. Additionally, the concept of workers' skills is quite vague. This is especially so in the case of the Japanese labor market where strong company orientation makes employees less occupation-conscious as compared with their Western counterparts. Admittedly, either education level, or task-aggregated occupational data usually serves as a good proxy for worker skill level.

⁴ The JIP 2013 database is the result of a collaboration between the Research Institute of Economy, Trade and Industry (RIETI) as a part of its "Study on Industry-Level and Firm-Level Productivity in Japan", and the Institute of Economic Research, Hitotsubashi University as a part of its "21st-Century COE Program, Research Unit for Statistical Analysis in the Social Sciences (Hi-Stat)" project. The JIP 2006 can be accessed at <http://www.rieti.go.jp/en/database/d05.html>. The original version of the JIP database (JIP 2003) was compiled by the Economic and Social Research Institute, Cabinet Office, Government of Japan as part of its research project on "Japan's Potential Growth" and the Hi-Stat project.

⁵ The latest year available in the JIP database is 2011. However, import data partitioned by source countries at industry-level are only available to 2009. It should be also noted that annual trade data are only available after 1988.

⁶ Value-added is defined as the difference between gross output and intermediate inputs. Gross output is the sum of industry shipment, revenues from repairing and fixing services, and revenues from performing subcontracting work. Intermediate inputs are the sum of raw materials, fuels, electricity, and subcontracting expenditure.

This study adopts the latter approach, using five group occupations. Following Guadalupe (2007), these occupational groups are divided into high, medium, and low skill level as follows: technical workers (systems engineers and computer programmers) and managerial personnel (Tech and Managers) as a skilled group; administrative, advertising and sales workers as medium-skilled group (Office, Sales, Services); and blue-collar (manual workers, assemblers and operational workers) as a less-skilled group. We have these skill groups in each of 52 manufacturing industries for the entire period.

In practice, the occupational divide for workers closely tracks educational attainment. On the whole, the data reasonably support white-collar workers (those fall in medium and high skilled) having a higher education than production workers (blue-collar workers). For example, the employment share of university graduates among total non-production workers in Japanese manufacturing was around 50% in 2004, up from 39% in 1985. The employment share of high school graduates among total nonproduction workers has continued to decline from the mid-1980s, reaching 37% in 2004. The share of junior high school graduates accounted for only 3.4% of nonproduction workers, implying a high concentration in production workers.⁷

ICT Capital

We use ICT capital (real stock) divided by value added. ICT capital has been constructed using the perpetual inventory method based on real investment flows, using the quality adjusted price deflator available in JIP data. ICT capital is its stock multiplied by its user cost.⁸ We also include non-ICT capital in regressions; taken together, they constitute industry-level capital stock.

An Instrumental Variable

A common problem in the reduced form of the empirical approach is endogeneity: higher skilled worker concentrations might actually result in more intermediate input PRC imports. For the same reason, the reverse causality is also a possibility: PRC imports may be correlated with industry-wide demand for skilled workers (to some degree, industry-specific fixed effects may address this concern, though not if the omitted factors also vary across time). This renders the ordinary least squares (OLS) estimator as biased and inconsistent.

⁷ Of course, occupational segregation is not an entirely satisfactory proxy of workers' skill levels, for a number of reasons. First, there is the misclassification of jobs between nonproduction and production workers. For instance, according to the International Standard Classification of Occupations provided by the International Labour Organization (ILO), line supervisors and product development personnel are included among production workers, whereas delivery truck drivers and cafeteria workers are not. In relation to the misclassification of jobs into skilled/unskilled workers, Lawrence and Slaughter (1993) considered the example of an experienced machine-tool technician with a university degree in computer science who programs the computers driving the tools, and a recent high-school dropout who files the reports and runs mail: if both work for a manufacturing firm, the nonproduction/production distinction will clarify the technician as unskilled and the office runner as skilled. Another reason why occupational segregation is not a good proxy of workers' skill levels is related to the specific context of Japanese employment practice. Under the seniority wage system, workers with a long period of service receive a high salary regardless of educational attainment and job type. As a consequence, it is possible to observe inexperienced workers with skilled jobs receiving lower wages, and experienced workers with less skilled jobs. These considerations make it difficult to retain the assumption of factor substitutability between skilled and less-skilled workers.

⁸ See <http://www.rieti.go.jp/jp/database/JIP2015/index.html> for a detailed discussion of the variable construction.

We adopt an instrumental variable (IV) approach to minimize estimation bias. We further measure PRC labor productivity as an instrument for the endogenous import variables in the employment-share equation. This IV strategy extracts any exogenous variations affecting PRC export supply capacity, yet indirectly affects skill demand only through the intensified import competition in Japan. This instrument is inspired by those used in other studies: Autor et al. (2015) used eight advanced countries to construct the exposure to PRC import competition as pertained to the US. Their IV strategy is to extract exogenous supply-side productivity elements in PRC export performance. However, as pointed out in Autor et al. (2015), the instrument faces the validity challenge whereby industry skill demand changes among those advanced countries must be separate incidents. In our IV strategy, we directly use the labor productivity measure of PRC industries that have undoubtedly been behind the surge in export growth. These data are extracted from the China Industrial Productivity (CIP) database. There is no strict industry matching from CIP to JIP industries, so we arbitrarily assigned the corresponding CIP manufacturing industries to 52 JIP industries.

3.2 Other Control Variables

Other variables are sourced from the JIP 2013 database. Value-added is used to measure the industry output. The ratio of non-IT capital stock to value-added is used to measure capital intensity of production (denoted as K).⁹ R&D intensity is also included to control for the industry-specific time-varying technological capacity.

4. EMPIRICAL RESULTS

4.1 Main Results

We start from running regressions on a simpler version of Eq. (1) with PRC import competition (CHN) as a single control variable (panel A, Table 2). To aid in interpreting the results, summary statistics are presented in Appendix Table 1A. In each regression, we have the following skill groups in the employment share regressions: Production workers, Office, Sales, Services, Technical, and Managers.

The main finding is that PRC import competition has the statistically significant positive effect on change in industry skill upgrading, raising the skill demand of Technical workers: a 10% increase in CHN would lead to a 6.2 percentage point increase in the employment share of Tech workers (column 5).¹⁰ On the other hand, as expected, the higher intensity of PRC import competition would depress the employment share of Production workers (column 1). Middle-skilled occupations (Office, Sales, and Service) do not seem to be much affected by PRC import competition.

⁹ Gross output is measured as the sum of industry shipment, revenues from repairing and fixing services, and revenues from performing subcontracting works. Intermediate inputs are defined as the sum of raw materials, fuels, electricity, and subcontracting expenditure. They are available in real terms in the JIP 2006 database. Real value-added is defined as the difference between real gross output and real intermediate inputs. Capital stock refers to the nominal book value of tangible fixed assets including buildings, machinery tools, and transport equipment.

¹⁰ In the experimental stage, we used two measures of CHN in Eq. (2) and (3), but they are essentially the same; as a result, we only report Eq. (2).

Table 2: Evidences of PRC Import Competition on Employment Share by Skill Category, 1980–2009

Dependent variable (Sh) = Employment share by the skill category of workers

	(1) Prod	(2) Office	(3) Sales	(4) Services	(5) Tech	(6) Managers
Panel A						
PRC import penetration	−0.950**	0.150	0.171	0.014	0.622***	−0.022
(1-year lag)	(0.432)	(0.158)	(0.157)	(0.011)	(0.123)	(0.078)
_cons	70.912***	15.937***	4.476***	0.037	4.717***	2.887***
	(1.817)	(0.617)	(0.699)	(0.050)	(0.567)	(0.368)
Industry Fixed Effects	YES	YES	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES	YES	YES
N	1,146	1,146	1,146	1,146	1,146	1,146
R-sq	0.162	0.442	0.203	0.613	0.275	0.819
F	10.244	16.726	13.598	57.490	11.345	51.630
Panel B						
PRC import penetration	−0.757*	0.053	0.324*	0.021	0.282**	0.042
(1-year lag)	(0.434)	(0.162)	(0.180)	(0.013)	(0.126)	(0.055)
Real ICT capital over value added	0.862	−0.475	0.094	−0.005	−0.281	−0.215
(2-years lag)	(1.092)	(0.592)	(0.379)	(0.013)	(0.679)	(0.193)
Real non-ICT capital over value added	−0.001	0.001	0.000	−0.000	0.000	−0.000
(2-years lag)	(0.003)	(0.001)	(0.001)	(0.000)	(0.002)	(0.000)
Real value added	0.714	−0.249	−0.665**	−0.035	0.685	−0.486
(2-years lag)	(1.474)	(0.610)	(0.317)	(0.021)	(0.882)	(0.326)
Real R&D over value added	1.611	−0.609	−0.792**	−0.015	−0.217	0.013
(2-years lag)	(1.138)	(0.534)	(0.305)	(0.012)	(0.609)	(0.189)
_cons	51.643**	23.348**	16.220***	0.605*	−2.752	10.627*
	(22.854)	(9.549)	(5.288)	(0.330)	(14.734)	(5.608)
Industry-Fixed Effects	YES	YES	YES	YES	YES	YES
Year-Fixed Effects	YES	YES	YES	YES	YES	YES
N	1,078	1,078	1,078	1,078	1,078	1,078
R-sq	0.187	0.469	0.256	0.518	0.275	0.839
F	8.743	27.105	21.780	39.246	10.103	74.823

Notes: All control variables are in natural logarithms. Weighted least-square (WLS), weights equal to the industries' employment share in total manufacturing. JIP industry-clustered standard errors are given in brackets, with statistical significance (two-tailed test) denoted as: *** 1 percent, ** 5 percent, and * 10 percent.

Source: JIP 2013 database.

This result remains robust even after controlling for other confounding factors such as ICT (and non-ICT) investment capital stock, and R&D intensity and outputs (panel B, Table 2). All the estimated PRC import competition coefficients diminish once other control factors are included. The estimated coefficient on ICT capital intensity suggests that utilization is found to be statistically insignificant with an unexpected negative sign in the skilled employment share (columns 5 and 6, panel B of Table 2). This finding is markedly different from the commonly found robust complementary relationship between ICT capital utilization and skilled workers in US manufacturing (e.g., Berman, Bound and Griliches 1994). However, this is consistent with a previous study in Japanese manufacturing (e.g., Sakurai 2001). The result for the R&D intensity variable (a proxy for general SBTC) also suggests a negative, but statistically insignificant effect

on Technical workers (column 5). By and large, it indicates a dominant factor of PRC import competition raising skill demand.

Table 3: Robustness Checks

Dependent variable (Sh) = Employment share by worker skill category

	(1) Prod	(2) Office	(3) Sales	(4) Services	(5) Tech	(6) Managers
Panel A						
PRC import penetration	-0.960**	0.156	0.153	0.013	0.649***	-0.019
(1-year lag)	(0.449)	(0.166)	(0.156)	(0.011)	(0.138)	(0.079)
CHN export exposure	-0.077	0.045	-0.127	-0.007	0.192	0.027
(1-year lag)	(0.388)	(0.161)	(0.142)	(0.006)	(0.227)	(0.051)
_cons	71.180***	15.779***	4.916***	0.062	4.052***	2.793***
	(2.486)	(0.962)	(0.822)	(0.057)	(1.099)	(0.434)
Industry Fixed Effects	YES	YES	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES	YES	YES
N	1,142	1,142	1,142	1,142	1,142	1,142
R-sq	0.162	0.442	0.211	0.617	0.279	0.819
F	12.571	24.484	6.721	65.386	13.340	41.338
Panel B						
PRC import penetration	-1.315**	0.206	0.440*	0.029*	0.604**	0.027
(1-year lag)	(0.647)	(0.285)	(0.228)	(0.017)	(0.240)	(0.080)
Import penetration: NIEs	0.495	-0.166	-0.076	-0.008	-0.117	-0.129
(2-years lag)	(0.602)	(0.248)	(0.127)	(0.008)	(0.257)	(0.108)
Import penetration: High income	0.883	-0.382	-0.472**	-0.018	-0.000	-0.043
(2-years lag)	(1.068)	(0.414)	(0.227)	(0.017)	(0.530)	(0.112)
_cons	39.157	26.645***	17.370***	0.762*	7.400	8.108*
	(24.305)	(9.530)	(5.275)	(0.436)	(10.389)	(4.231)
Industry Fixed Effects	YES	YES	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES	YES	YES
N	1006	1006	1006	1006	1006	1006
R-sq	0.139	0.426	0.252	0.523	0.187	0.850
F	5.313	8.710	8.335	21.166	4.989	57.107

Notes: All control variables are in natural logarithms. Weighted least-square (WLS), weights equal to the industries' employment share in total manufacturing. JIP industry-clustered standard errors are given in brackets, with statistical significance (two-tailed test) denoted as: *** 1 percent, ** 5 percent, and * 10 percent.

Source: JIP 2013 database.

The well-known practice of Japanese companies is to undertake assembly activities by exporting parts and components to the PRC (offshoring), while retaining capital- and technology-intensive production (Head and Ries 2002). We therefore add an industry's exports to the PRC as an additional control (panel A, Table 3).¹¹ The export variable has no statistical significance and neither does it change the PRC import competition coefficient. It seems that the intensified PRC import competition can only trigger the offshoring of basic skill jobs, which can then lead to increased skill intensity at Japanese industries; there is no such evidence vis-à-vis exporting.

¹¹ This is constructed similarly to import competition in which we take the ratio of exports to the PRC against industry's overall exports.

In panel B of Table 3, we introduce industry import penetration from Asian NIEs (Singapore; Republic of Korea; Hong Kong, China; and Taipei, China), and other high-income economies (those in high wage countries in OECD). Inclusion of this additional import competition seems to magnify the estimated coefficient for PRC imports for some skill categories. For instance, a 10% increase in PRC import penetration now accounts for a 13 percentage point decrease in Production employment share (column 1).

Table 4 presents results based on the IV method using the corresponding PRC labor productivity as an instrument for import competition. The broad result is consistent with the prior finding: PRC import competition raises demand for skilled occupations, while depressing that of production and manual workers. However, the reported estimated coefficients are much larger than the OLS results in Table 2. Further verification and an instrument validity test need to be implemented.

Table 4: Instrumental Variable Estimates of PRC Import Competition on Skill Upgrading Effects in Japan, 1980–2009

Dependent variable (Sh) = Employment share by the worker skill category

Panel A	(1) Prod	(2) Office	(3) Sales	(4) Services	(5) Tech	(6) Managers
PRC import penetration (1-year lag)	−2.450*** (0.368)	0.757*** (0.148)	0.299*** (0.079)	0.028*** (0.007)	1.207*** (0.182)	0.093** (0.038)
_cons	76.593*** (0.637)	11.826*** (0.251)	5.912*** (0.275)	0.286*** (0.018)	0.532** (0.224)	3.341*** (0.075)
N	1,078	1,078	1,078	1,078	1,078	1,078
F	934.097	893.080	415.693	73.779	801.526	451.637

Notes: All control variables are in natural logarithms. Weighted least-square (WLS), weights equal to the industries' employment share in total manufacturing. JIP industry-clustered standard errors are given in brackets, with statistical significance (two-tailed test) denoted as: *** 1 percent, ** 5 percent, and * 10 percent.

Source: JIP 2013 database.

5. CONCLUSION

This paper assesses empirically whether PRC import competition explains skill upgrading in a panel of 52 Japanese manufacturing industries for the period 1980–2009. Our empirical results provide evidence of skill upgrading due to PRC import competition. In particular, PRC imports have the positive effects of changing the composition of skilled demand towards technical workers and depressing demand for production and manual workers. This result is remarkably robust for the inclusion of ICT capital investment (a proxy for SBTC), export intensity to the PRC, and import competition from other economies.

The results shown in this paper indicate that PRC import competition works in favor of skilled workers by raising skill demand. This trend will continue due to an expansion in offshoring activities of Japanese firms. However, there is already an indication that the PRC is also moving up the technological ladder (rather than having specialized in the labor-intensive segment in highly technological goods). PRC import competition may then yield different pressures to skilled workers. It is less likely that such competition would substitute for skilled workers in Japan. Rather, workers and firms will be placed under much stronger pressure to innovate and further push into the world technological frontier.

REFERENCES

- Angrist, J., and J. Pischke. 2009. *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton: Princeton University Press.
- Ashournia, D., J. R. Munch, and D. Nguyen. 2014. The Impact of Chinese Import Penetration on Danish Firms and Workers, Working paper No. 703, Department of Economics, Oxford University.
- Athukorala, P. and N. Yamashita. 2006. Production Fragmentation and Trade Integration in a Global Context. *North American Journal of Economics and Finance* 17(4): 233–256.
- . 2009. Global Production Sharing and Sino-US Trade Relations. *China & World Economy* 17(3): 39–56.
- Autor, D., D. Dorn, and G. Hanson. 2013. The China Syndrome: Local Labour Market Impacts of Import Competition in the United States, *American Economic Review* 103(6): 2121–2168.
- Autor, D., et al. 2015. Trade Adjustment: Worker Level Evidence, *Quarterly Journal of Economics* 129(4): 1799–1860.
- Berman, E., J. Bound, and Z. Griliches. 1994. Changes in the Demand for Skilled Labour within U.S. Manufacturing: Evidence from the Annual Survey of Manufactures. *Quarterly Journal of Economics* 109: 367–97.
- Bernard, A. B., J. B. Jensen, and P. K. Schott. 2006. Survival of the Best Fit: Exposure to Low-Wage Countries and the (Un)even Growth of U.S. Manufacturing Plants, *Journal of International Economics* 68(1): 219–237.
- Bloom, N., M. Draca and J. V. Reenen. 2015. Trade Induced Technical Change? The Impact of Chinese imports on innovation, IT and Productivity, *Review of Economic Studies* 83(1): 87–117.
- Ebenstein, A., A. Harrison, M. McMillan and S. Phillips. 2014. Estimating the Impact of Trade and Offshoring on American Workers Using the Current Population Surveys, *The Review of Economics and Statistics* 96(3): 581–595.
- Egger, H., and P. Egger. 2003. Outsourcing and Skill-Specific Employment in a Small Economy: Austria after the Fall of the Iron Curtain. *Oxford Economic Papers* 55(4), 625–643.
- Feenstra, R. C., and G. H. Hanson. 1996. Globalization, Outsourcing, and Wage Inequality. *American Economic Review* 86, 240–245.
- . 1999. The Impact of Outsourcing and High-Technology Capital on Wages: Estimates for the United States, 1979–1990. *The Quarterly Journal of Economics* 114(3), 907–940.
- Hansson, P., 2000. Relative Demand for Skills in Swedish Manufacturing: Technology or Trade? *Review of International Economics* 8(3): 533–555.
- Head, K., J. Ries. 2002. Offshore Production and Skill Upgrading by Japanese Manufacturing Firms. *Journal of International Economics* 58(1): 81–105.
- Hijzen, A., H. Görg, and R. C. Hine. 2005. International Outsourcing and the Skill Structure of Labour Demand in the United Kingdom. *The Economic Journal* 115(506): 860–878.

- Hsieh, C. T., and K. T. Woo. 2005. The Impact of Outsourcing to China on Hong Kong's Labour Market. *The American Economic Review* 95(5): 1673–1687.
- Hummels, D., R. Jorgensen, J. R. Munch, and C. Xiang. 2014. The Wage Effect of Offshoring: Evidence from Danish Matched Worker-Firm Data. *American Economic Review* 104(6): 1597–1629.
- Ikenaga, T., and R. Kambayashi. 2016. Task Polarization in the Japanese Labor Market: Evidence of a Long-term Trend, forthcoming in *Industrial Relations*.
- Krishna, P., J. P. Poole, and M. Z. Senses. 2014. Wage Effects of Trade Reform with Endogenous Worker Mobility, *Journal of International Economics* 93(2): 239–252.
- Mion, G. and Z. Linke. 2013. Import Competition from and Offshoring to China: A Curse or Blessing for Firms? *Journal of International Economics* 89(1): 202–215.
- Rodrik, D. 2006. What's So Special about China's Exports? *China & World Economy*, 14(5): 1–19.
- Sakurai, K. 2001. Biased Technological Change and Japanese Manufacturing Employment. *Journal of the Japanese and International Economies* 15(3): 298–322.
- Schott, P. K. 2008. The Relative Sophistication of Chinese Exports, *Economic Policy* 23(53): 5–49.
- Tomiura, E., 2005. Foreign Outsourcing and Firm-level Characteristics: Evidence from Japanese Manufacturers. *Journal of the Japanese and International Economies* 9(2): 255–271.

APPENDIX

Table A1: Summary Statistics

	Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Skill measures	Prod	1,488	65.97	8.74	38.74	83.90
	Office	1,488	16.20	4.00	6.85	33.33
	Sales	1,488	5.12	2.52	1.35	15.02
	Service	1,488	0.20	0.16	0.00	1.10
	Tech	1,488	6.61	4.66	0.24	25.11
	managers	1,488	4.19	1.42	1.04	8.42
Controls	PRC import penetration	1,146	1.78	1.93	-8.09	4.58
	Real ICT capital over value added	1,392	2.48	1.23	-2.88	6.09
	Real non-ICT capital over value added	1,392	236.84	355.13	0.59	5,648.12
	Real value added	1,392	14.21	0.99	9.35	17.99
	Real R&D over value added	1,363	3.55	1.45	0.21	8.02
	Import penet. From Asian NIEs ¹	1,104	21.44	2.17	-5.76	25.61
	Import penet. From high income ²	1,104	23.05	1.76	13.57	25.53
	Export to the PRC	1,148	1.61	1.36	-5.84	4.16

Obs. = observations; std. dev. = standard deviation.

Notes: 1. All control variables are in logarithm. Asian NIEs are Singapore; Republic of Korea; Hong Kong, China; and Taipei, China. 2. High income countries are those in OECD countries.

Source: JIP 2013 database.

A2. Derivation of Cost-Share Equation

First, the cost minimization framework is described. Industry minimizes a quasi-fixed (short-run) cost function, $C(\mathbf{w}, y)$, in which output (y) and \mathbf{w} are a vector of production factors such as capital (k) as a fixed factor (as exogenous) and more-skilled and less-skilled labor as variable factors. The cost function takes a translog form, which is the second order Taylor series approximation linearly homogenous function with a concave in factor prices, as per Christensen et al. (1973). The translog short run cost function (C) with a subscript z denoting industry is then written as follows (a time subscription is dropped for convenience):

$$\begin{aligned}
 \ln c_z = & \alpha_0 + \sum_{i=1}^M \alpha_i \ln w_{z,i} + \sum_{k=1}^K \beta_k \ln x_{z,k} \\
 & + \frac{1}{2} \left(\sum_{i=1}^M \sum_{j=1}^M \gamma_{i,j} \ln w_{z,i} \ln w_{z,j} + \sum_{k=1}^K \sum_{l=1}^K \delta_{k,l} \ln x_{z,k} \ln x_{z,l} \right) \\
 & + \sum_{i=1}^M \sum_{k=1}^K \phi_{i,k} \ln w_{z,i} \ln x_{z,k}
 \end{aligned} \tag{A.1}$$

where w_i refers to the optimally chosen variable factor prices with subscripts denoting $i, j = 1, \dots, M$ and x_k denotes either the quantities of fixed inputs (capital), outputs or other structural parameters with subscripts $k, l = 1, \dots, K$.

Equation (A.1) requires the following linear parameter restrictions to satisfy the linearly homogenous property with respect to variable factor costs (w_i):

$$\gamma_{i,j} = \gamma_{j,i}, \quad \delta_{k,l} = \delta_{l,k}, \quad \sum_{i=1}^M \alpha_i = 1, \quad \text{and} \quad \sum_{i=1}^M \gamma_{i,j} = \sum_{i=1}^M \varphi_{i,k} = 0.$$

Differentiating equation (A.1) with respect to $\ln w_i$ yields the cost share of variable

factor i : $\frac{\partial \ln C_z}{\partial \ln w_i} = \left(\frac{\partial C}{\partial w} \right) \left(\frac{w_i}{C_z} \right)$ where $\left(\frac{\partial C}{\partial w} \right)$ refers to factor demand for input i by

Shephard's lemma. It follows that $\frac{\partial \ln C_z}{\partial \ln w_i} = \frac{E_i w_i}{C_z} = S_{z,i}$ is equal to the share of factor i

in total costs, denoted by $S_{z,i}$ (where E is a factor i employment). In the end, it yields a cost share equation of variable factor of input i :

$$S_{z,i} = \alpha_i + \sum_{j=1}^M \ln w_{z,j} + \sum_{k=1}^K \varphi_{i,k} \ln x_{z,k} \quad \text{and} \quad \sum_{i=1}^M S_{z,i} = 1. \quad (\text{A.2})$$

Equation (A.2) relates the cost share of variable factor i to factor prices and the output level and fixed input capital. A cost share for variable factor j can be similarly derived. By assuming the coefficients of independent variables are equal across all industries, equation (A.2) can be pooled cross-industry and by time.